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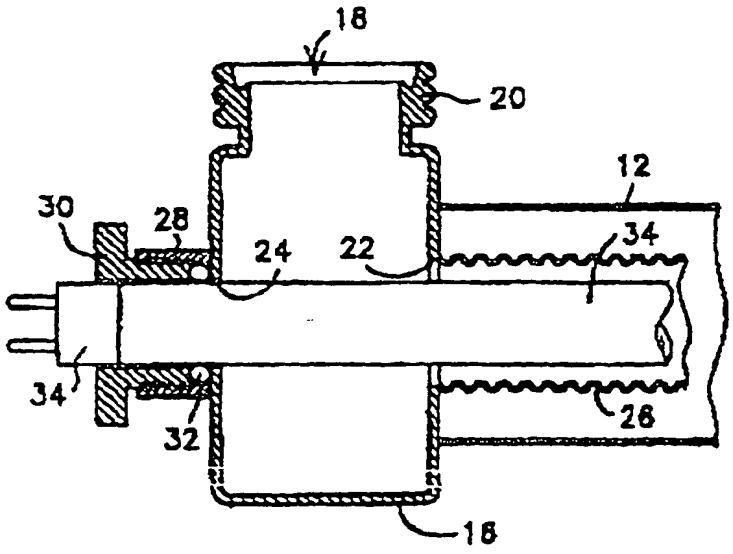
(54) Title: STERILIZATION OF LIQUIDS USING ULTRA-VIOLET LIGHT



(57) Abstract: A sterilizer for milk and other liquids is disclosed, the sterilizer having an elongate outer housing (12) with a manifold (16) at each end. Diary fittings (20) forming the inlet to and outlet from the sterilizer protrude from the manifolds (16). A sheath (26) of stainless steel extends along the housing (12) and a UV light fluorescent tube extends along the sheath. The sheath has an internal configuration providing protuberances over which the liquid to be sterilized flows. This imparts turbulence to the flowing liquid or, if the inlet manifold (16) and fitting (20) are themselves arranged to impart turbulence in the form of a swirling motion of the incoming liquid, help to maintain the turbulence throughout the length of the sheath (26).

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STERILIZATION OF LIQUIDS USING ULTRA-VIOLET LIGHT

FIELD OF THE INVENTION

THIS INVENTION relates to the sterilization of liquids using ultra-violet light.

The use in this specification of the term "sterilization" is meant to indicate a reduction in bacterial count in a liquid, and not necessarily a total elimination of bacteria.

BACKGROUND TO THE INVENTION

The use of ultraviolet (UV) light for the purpose of sterilizing a liquid is well known. A problem that arises with a turbid liquid is that the light does not penetrate very far into the liquid and hence liquid furthest from the UV lamp may not be sterilized at all or may not be properly sterilized.

South African patent specification 96/8029 discloses an elongate sterilizer in which a fluorescent tube is within, and co-axial with, an elongate housing. The sterilization chamber is between the fluorescent tube and the housing. The liquid inlet and liquid outlet are arranged tangentially with respect to the housing in an effort to cause the liquid to swirl and overcome the difficulty referred to above. It has been

found, however, that the swirling motion imparted to the liquid as it enters the housing does not continue throughout the length of the housing, thus limiting the beneficial effect.

Other structures are known, such as that shown in US patent 5,675,153, in which there is a helical vane in the space between the fluorescent tube and the housing, the vane extending from one end of the housing to the other. The vane is slotted and there is a gap between the vane and the inner surface of the housing. Such a structure would be completely unsuitable for the sterilization of milk, because of the many sharp corners where flow would stagnate and bacteria would be able to multiply. There is a tendency for solids in milk to deposit on the surfaces defining the flow passage, in regions where there is an insufficient flow velocity, so that the structure of US patent 5,575,153, if it were to be used for the sterilization of milk, would suffer from deposits and as a consequence require frequent cleaning. The structure would, in any event, be difficult to clean to the degree that is required in apparatus that is used for the handling of milk.

BRIEF DESCRIPTION OF THE INVENTION

According to one aspect of the invention there is provided a sterilizer for reducing the bacteria count in a liquid, the sterilizer comprising an elongate sheath, an elongate fluorescent tube extending along the sheath, there being a gap between the tube and the sheath through which gap the liquid to be sterilized flows, said sheath

having an internal configuration including protuberances over which, in use, the liquid flows and which impart turbulence to the flowing liquid.

In one form the sheath has a spiral groove in the inner face thereof with a spiral land between adjacent turns of the groove, the land forming said protuberances over which the liquid being sterilized flows. The shape of the protuberances is preferably such that they provide the inner surface of the sheath with a smoothly curved, undulating configuration.

Preferably said tube and sheath are within and extend along an elongate outer housing.

According to a further aspect of the present invention there is provided a method of reducing the bacteria count in milk, the method comprising causing the milk to flow from a milking machine to a sterilizer in which the milk is subjected to ultraviolet radiation, the milk being subjected to said ultraviolet radiation before it cools to below 28°C.

The method can include the further step of cooling the milk down to storage temperature after subjecting it to ultraviolet radiation.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:-

Figure 1 is a side elevation of a sterilizer in accordance with the present invention;

Figure 2 is a longitudinal section through one end of the sterilizer, drawn to a larger scale;

Figure 3 is a cross-section on line III-III of Figure 1, drawn to the same larger scale;

Figure 4 is a detail of part of Figure 2: and

Figure 5 is schematic diagram of a milk sterilization installation in accordance with the invention.

DETAILED DESCRIPTION OF THE DRAWINGS

Referring firstly to Figures 1 to 4, the sterilizer 10 illustrated is designed specifically for the purpose of sterilizing milk but can be used to sterilize not only turbid liquids but also transparent or translucent liquids. The sterilizer comprises an elongate stainless steel outer housing 12 which is circular in cross section. A mounting plate 14 is tack welded to the housing 12 midway between its ends (see Figure 3). In another form the outer housing 12 is square in cross section.

At each end of the housing 12 there is an manifold 16, one manifold forming an inlet for milk to be sterilized, and the other manifold forming an outlet for sterilized milk. The manifolds 16 each have a port 18. The ports are each in a conventional male dairy fitting 20 whereby a hose can be attached thereto. The fitting 20 of one manifold 16 is to one side of the vertical centre plane of the sterilizer (as shown in full lines in Figure 3) and the fitting 20 of the other manifold 16 is to the other side of the centre plane as shown in dotted lines in Figure 3.

Each manifold 16 has aligned openings 22, 24 in opposite walls thereof. The sterilizer further comprises a corrugated sheath 26 which is aligned with the opening 22 and extends the full length of the housing 12 between the manifolds 16.

Each manifold 16 has an internally threaded socket 28 secured thereto, the sockets 28 being aligned with the openings 24

An externally threaded bush 30 is screwed into each socket 28 and there is a sealing ring 32 between each bush 30 and the wall of the manifold.

A fluorescent tube 34 (also referred to as a germicidal UV lamp) passes through the bushes 30, sockets 28, sealing rings 32, manifolds 16 and sheath 26, the ends of the fluorescent tube protruding from the bushes 30. When the bushes 30 are tightened the sealing rings 32 are compressed and grip the fluorescent tube 34, thereby

forming liquid-tight seals.

The sheath 26 is of stainless steel and is formed with a helically extending corrugation. As can best be seen in Figure 4, the helical corrugation has a pitch P of about 6mm and provides the inside of the tube with a smoothly curved undulating surface when the tube is viewed in radial cross section, without any sharp corners or discontinuities where flow stagnation can occur.

The sheath 26 has a nominal diameter of about 40mm. Being of stainless steel, the inner surface of the sheath 26 is reflective. The radial gap between the fluorescent tube 34 and the sheath 26 varies between about 5mm at the troughs of the corrugations (the distance d) to about 7mm at the crests (the distance D).

In another form the sheath 26 has a spiral groove extending along the inner face thereof with a spiral land separating adjacent turns of the groove. The gap between the land and the outer face of the tube 34 is approximately 5mm.

Milk flowing through the sterilizer 10 passes through the narrow annular gap between the fluorescent tube 34 and the corrugated sheath 26. As the milk flows into the sterilizer a swirling motion is imparted to it, and hence turbulence is introduced, by the tangential position of the inlet fitting 20. The corrugations maintain, throughout the length of the sterilizer, the turbulence introduced into the milk as it flows into the

manifold. This ensures that all the milk is subjected to UV light. The tangential arrangement of the outlet fitting 20 ensures that the milk flows smoothly out of the sterilizer without the fitting causing a back pressure which could dampen the turbulent flow.

If the inlet manifold and fitting do not impart turbulence to the incoming liquid, then the surface of the sheath breaks up the smooth flow of the incoming liquid and introduces turbulence.

It has been found that the best results are obtained when the velocity of the milk flowing through the gap between the fluorescent tube 34 and the sheath 26 is about 3 m/s, preferably between 3 and 3.5 m/s. At lower flow velocities there is a fall off in the turbulence that is required to ensure a proper irradiation of all the milk. At higher flow velocities, there is a tendency for butter formation to take place. There is also at higher velocity a tendency for the tube 34 to be coated thereby blocking off UV light.

Referring now to Figure 5. reference numeral 36 generally indicates an installation for sterilizing milk, the installation being erected on a dairy farm and including a sterilizer 10 of the type described above with reference to Figures 1 to 4.

The installation 36 comprises a pump 38, a first filter 40 connected upstream of the sterilizer 10, a second filter 42 connected downstream of the sterilizer

10, and a bulk cooler tank 44. The pump 38 has its suction inlet connected to the milk collecting bowl 46 of a milking machine, and pumps the milk from the milk collecting bowl to the bulk cooler tank 44 via the first filter 40, the sterilizer 10 and the second filter 42. Cooling of the milk takes place in the tank 44.

The installation 36 includes a bypass line 48 bypassing the sterilizer 10. Bypass valves 50 are provided to divert flow from the sterilizer 10 to the bypass line and to isolate the sterilizer. If desired, the bypass line 48 may be substituted by a second sterilizer 10 so that flow can be diverted from one sterilizer to the other.

The filter 40 is provided to filter out hair and other dirt from the milk that is received from the milk collecting bowl. The second filter 42 is provided as a safety feature, to prevent glass fragments or other parts of the fluorescent tube 34 from finding their way into the tank 44 in the event of a breakage.

Two or more sterilizers 10 can be provided in series.

It is an important feature of the invention that the milk is subjected to ultraviolet radiation in the sterilizer 10 while the milk is still warm. The fatty constituents of milk start to separate from the rest of the milk when the temperature falls below 28°C. This is referred to as "crystallization". By passing the milk through the sterilizer while the milk is still at a temperature of 28°C or above the tendency of the fatty constituents to

collect on the inside surfaces of the sterilizer is minimized. Thus sterilization occurs before the milk cools to below 28°C.

While the use of the sterilizer 10 to irradiate milk has been described above, it is to be understood that the sterilizer could also be used to sterilize other liquids. For example, it could be used to sterilize liquids such as wine and petroleum.

CLAIMS:

1. A sterilizer for reducing the bacteria count in a liquid, the sterilizer comprising an elongate sheath, an elongate fluorescent tube extending along the sheath, there being a gap between the tube and the sheath through which gap the liquid to be sterilized flows, said sheath having an internal configuration including protuberances over which, in use, the liquid flows and which impart turbulence to the flowing liquid.

2. A sterilizer as claimed in claim 1, wherein the sheath has a spiral groove in the inner face thereof with a spiral land between adjacent turns of the groove, the land forming said protuberances over which the liquid being sterilized flows.

3. A sterilizer as claimed in claim 1 or 2, wherein said tube and sheath are within and extend along an elongate outer housing.

4. A sterilizer as claimed in claim 1, wherein the protuberances provide the inner surface of the sheath with a smoothly curved, undulating configuration.

5. A stabilizer as claimed in claim 1 or 2, and including an inlet which is offset with respect to the sheath and the tube so as to cause the incoming liquid to swirl in the sheath.

6. A sterilizer as claimed in claim 5, and including an outlet which is offset with respect to the sheath and the tube, the outlet being so positioned that the liquid flowing in said gap, and which has a swirling action imposed on it, flows into said outlet which is generally tangential to the swirling liquid.

7. A method of reducing the bacteria count in milk, the method comprising causing the milk to flow from a milking machine to a sterilizer in which the milk is subjected to ultraviolet radiation, the milk being subjected to said ultraviolet radiation before it cools to below 28°C.

8. A method as claimed in claim 5, and comprising cooling the milk down to storage temperature after subjecting it to ultraviolet radiation.

9. A sterilizer for reducing the bacteria count in a liquid substantially as hereinbefore described with reference to the accompanying drawings.

10. A method of reducing the bacteria count in milk substantially as hereinbefore described with reference to the accompanying drawings.

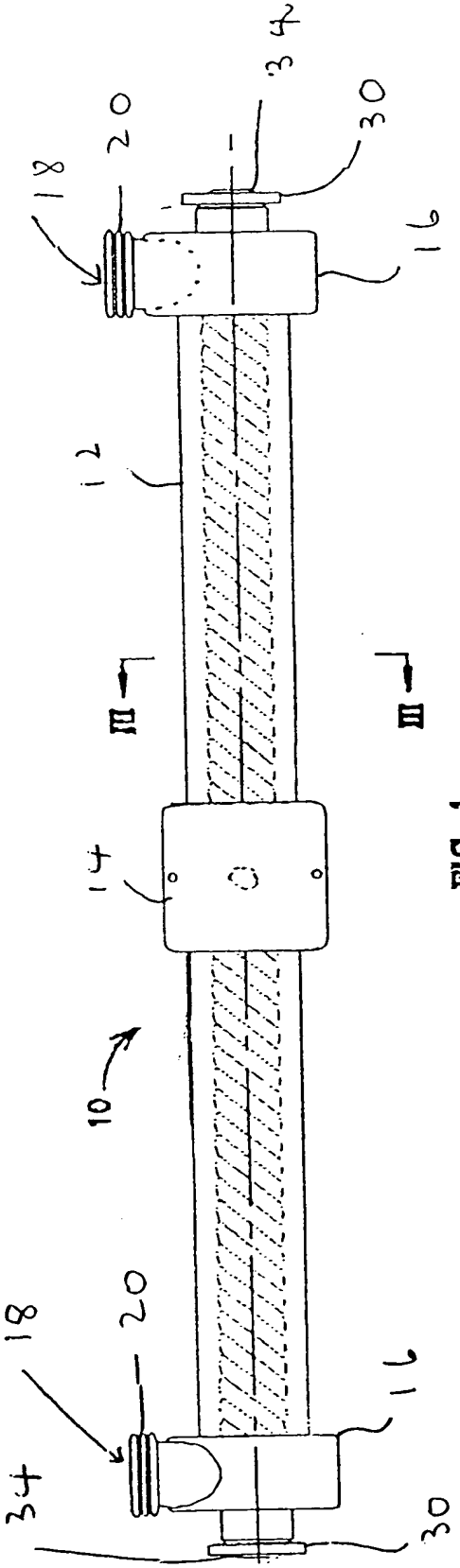

FIG 1

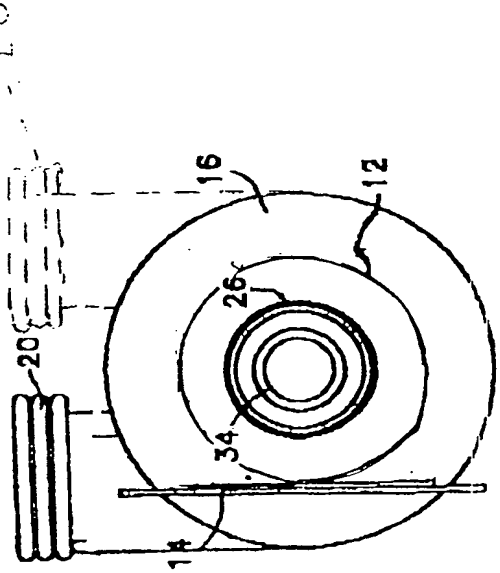

FIG 3

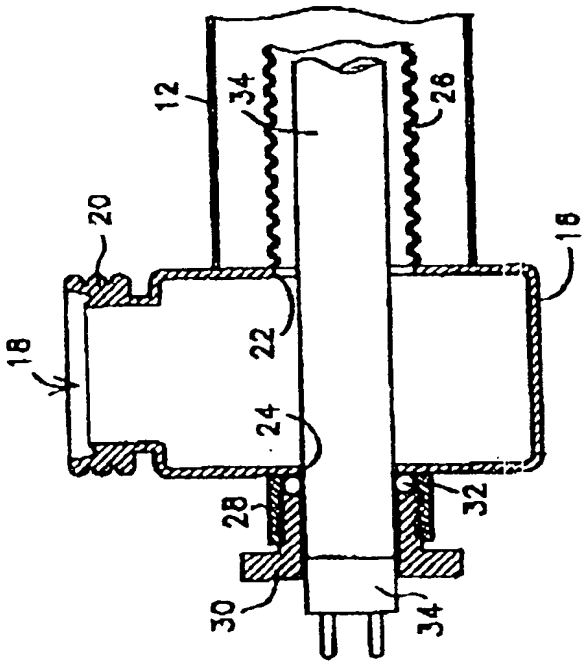

FIG 2

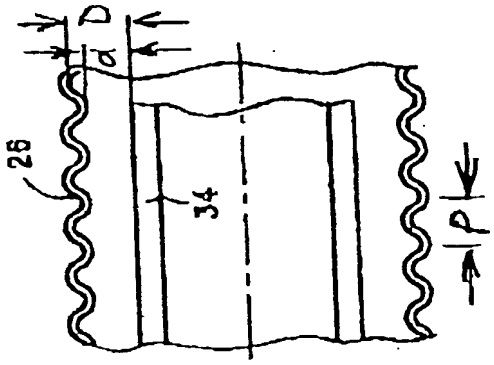

FIG 4

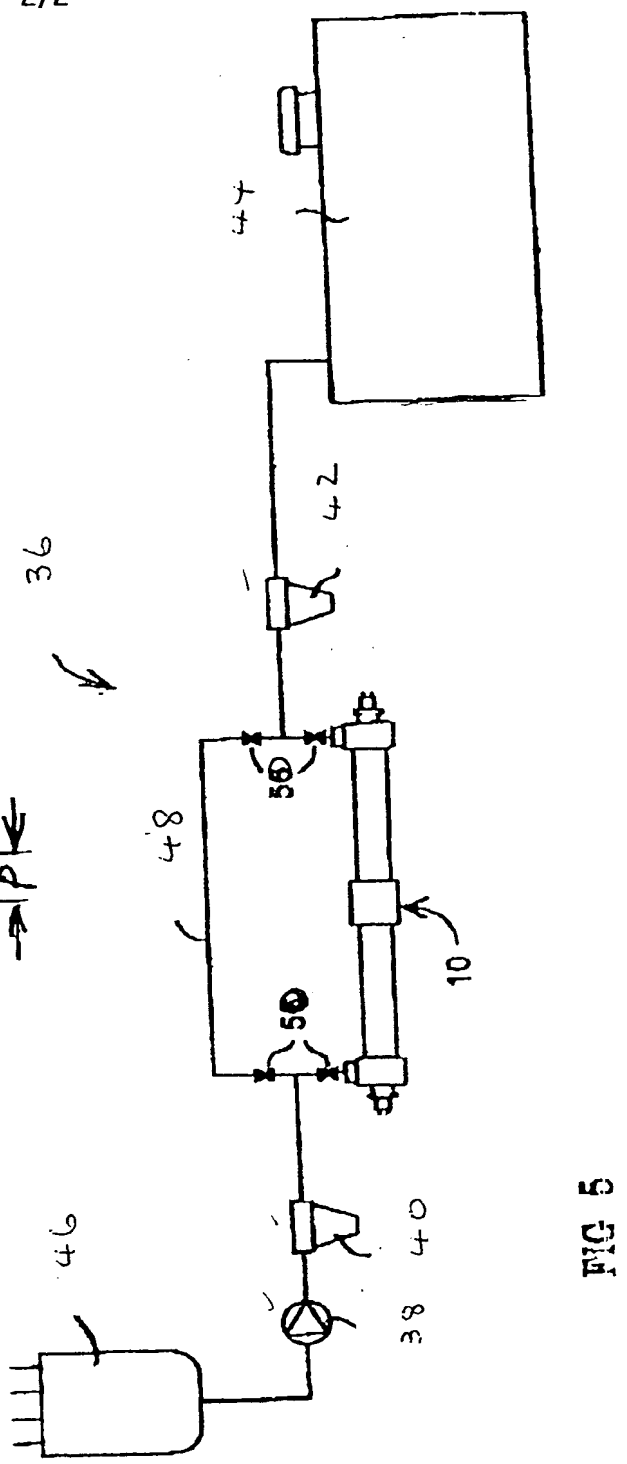

FIG 5

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(74) Agent: **BACON, Brian**; Brian Bacon & Associates, 2nd floor, Mariendahl House, Fedsure on Main, Main Road, Newlands 7700 (ZA).

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(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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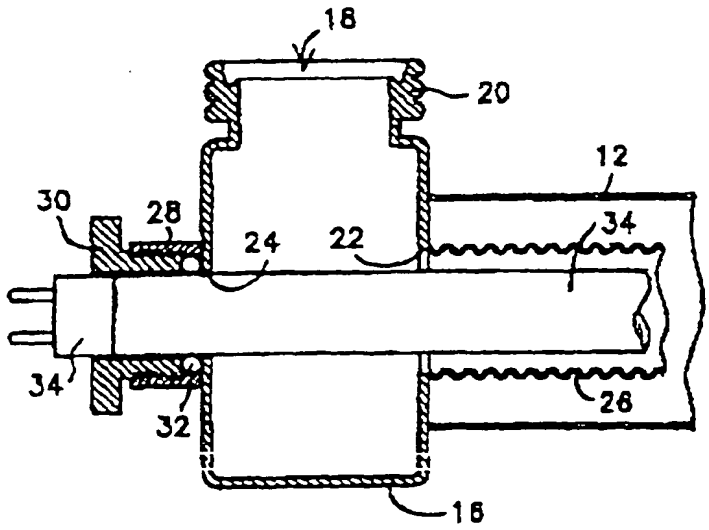

(57) Abstract: A sterilizer for milk and other liquids is disclosed, the sterilizer having an elongate outer housing (12) with a manifold (16) at each end. Diary fittings (20) forming the inlet to and outlet from the sterilizer protrude from the manifolds (16). A sheath (26) of stainless steel extends along the housing (12) and a UV light fluorescent tube extends along the sheath. The sheath has an internal configuration providing protuberances over which the liquid to be sterilized flows. This imparts turbulence to the flowing liquid or, if the inlet manifold (16) and fitting (20) are themselves arranged to impart turbulence in the form of a swirling motion of the incoming liquid, help to maintain the turbulence throughout the length of the sheath (26).

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A23C3/07 C12H1/16 A61L2/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A23C A61L C12H C02F B01J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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X	EP 0 202 820 A (STILL & SONS LTD W M) 26 November 1986 (1986-11-26) figures 1,2 ---	1,2,5,6, 9
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X	FR 1 310 471 A (CLAUDE AUSTIN) 8 March 1963 (1963-03-08) figure 1 --- -/--	1,4-6,9

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
9 May 2001	22/05/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Koch, J

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International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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